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US smokers' beliefs, experiences and perceptions of different cigarette variants before and after the FSPTCA ban on misleading descriptors such as 'light', 'mild', or 'low'

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ABSTRACT

Introduction. In December 2008, the Federal Trade Commission (FTC) rescinded its prior guidance that listing Cambridge or "FTC method" nicotine or tar levels on cigarette packs or ads did not violate the FTC Act, prompting the removal of such listings from packs and ads. As of June 2010, the U.S. Family Smoking Prevention and Tobacco Control Act effectively banned terms like 'light', 'mild' and 'low' and similar descriptors from cigarette packs and ads. This study evaluates the effect of these two policy changes on smokers' beliefs, experiences and perceptions of different cigarettes.

Methods. Using generalized estimating equations models, this study analysed survey data collected between 2002 and 2013 by the International Tobacco Control Policy Evaluation Study regarding U.S. smokers' beliefs, experiences, and perceptions of different cigarettes.

Results. Between 2002 and 2013, smoker misperceptions about 'light' cigarettes being less harmful did not change significantly and remained substantial, especially among those who reported using lower-strength cigarettes. After the two policy changes, reported reliance on pack colours, colour terms, and other product descriptors like 'smooth' to determine cigarette strength style trended upward.

Conclusions. Policies implemented to reduce smoker misperceptions that some cigarettes are safer than others appear to have had little impact. Because of pack colours, colour terms, descriptors such as "smooth," cigarette taste or feel, and possibly other characteristics, millions of smokers continue to believe, inaccurately, that they can reduce their harms and risks by smoking one cigarette brand or sub-brand instead of another, which may be delaying or reducing smoking cessation.

IMPLICATIONS

What this study adds:

This study confirms that U.S. policies to reduce smoker misperceptions that some cigarettes are less harmful than others have not been successful. Following the removal of light/low descriptors and tar and nicotine numbers from cigarette packs and ads, pack colours, colour words, other descriptors (e.g., smooth), and sensory experiences of smoother or lighter taste have helped smokers to continue to identify their preferred cigarette brand styles and otherwise distinguish between which brands and styles they consider "lighter" or lower in tar and, mistakenly, less harmful than others. These findings provide additional evidence to support new enforcement or regulatory action to stop cigarettes and their packaging from misleading smokers about relative risk, which may be reducing or delaying quit attempts.

INTRODUCTION

In December 2008, the Federal Trade Commission (FTC) issued a notice rescinding its prior guidance that listing Cambridge method or "FTC method" nicotine and tar levels on packs and in advertisements was not a violation of the FTC Act, prompting cigarette companies to remove the tar/nicotine figures from their packs and ads. In addition, the 2009 Family Smoking Prevention and Tobacco Control Act (FSPTCA) gave the US Food and Drug Administration (FDA) broad authority to regulate tobacco products and their marketing.[1] Section 911 of the Act specifically addressed concerns about the deceptive marketing of so-called 'light' cigarettes.[2] As of 22 June 2010, the Act prohibited the use of explicit or implicit descriptors on tobacco packaging or in advertising that convey messages of reduced risk or exposure – specifically including the use of the words 'light', 'mild' and 'low' -- unless and until the manufacturer could demonstrate to the FDA that the messages conveyed by the descriptors were accurate and not misleading and that allowing the descriptors would benefit the public health.[2, 3] Prior to the enactment of the FSPTCA, it was well understood that smokers mistakenly believed that light/low cigarettes were less harmful than regular cigarettes, which reduced cessation rates and maintained higher smoking levels and harms.[4]

Prior to the US ban on misleading brand descriptors in 2010, over 50 other countries had similarly banned misleading brand descriptors.[5] Studies evaluating the impact of the bans on misleading brand descriptors have generally concluded that such bans have not been able to substantially, much less completely, eliminate smoker misperceptions that some cigarette brands and sub-brands are less harmful than others.[6, 7] In many of these countries, the industry anticipated or responded to the descriptor bans by introducing colour-related words such as 'gold', 'silver' and 'blue' on packs as replacement descriptors along with altering elements of

packaging design (e.g. colour, brand imagery), and cigarette engineering (e.g., filter venting), in an effort to differentiate brands so that smokers would continue identifying some cigarette brands and sub-brands as 'light', 'mild', or 'low'.[7-13] Evidence from both experimental studies[8, 11, 14, 15] and population-based, observational studies[3, 9] suggests that the use of colour, whether done through the use of colour words, different pack colours, or different colouring of the cigarettes and filters, continues to perpetuate the myth that cigarette vary in terms of health risks and harms, which can reduce or delay smoking cessation.

Yong et al[7] evaluated the impact on smokers' misperceptions following the ban on the terms 'light' and 'mild' in the UK in 2003 and in Australia in 2006, comparing them with the US and Canada, which had no such bans at the time of the study. They found that the bans were followed by only a short-term reduction in the belief that 'light/mild' cigarettes confer some health benefits, and concluded that the temporary decline in this misunderstanding was largely the result of each country complementing the bans with a temporary mass media public education campaign. They based this conclusion on the fact that such misperceptions also declined over the study period in the US, which had not implemented a ban, following several widely publicized, high-profile court cases against the tobacco industry for misleadingly marketing cigarettes labelled as 'light'.[6, 7]

Cigarette companies have frequently argued that their use of pack colours and brand descriptors are merely intended to communicate differences between brands/sub-brands with regards to taste and texture. However, research evidence shows that consumer perceptions of product risk is also related to taste and sensory impact which can be influenced not just by the types of tobacco used or how products are engineered (e.g., filter ventilation)[16, 17] but even by the terms used to describe the brand or brand variant or the colour of the cigarette, its filter or its

packaging.[11] Ironically, increasing smoothness and lightness by filter ventilation may actually increase product risk by making the tar more mutagenic[18-20], but the cooling effect of oxygen mixing with the hot smoke will prompt smokers to experience the cigarette as lighter and easier on the throat (and mistakenly think it is less harmful than other cigarettes).[10, 21-24]

Because smokers' belief that light/low cigarettes are smoother on the throat and chest than regular cigarettes is directly linked to their beliefs that light/low cigarettes are safer or less harmful than other types of cigarettes, monitoring trends in this sensory belief, and the factors influencing that belief, is important. Past research found smokers' belief that 'light' cigarettes are smoother on the throat and chest than regular cigarettes declined between 2002 and 2006,[6] but the reason for this trend and whether it would persist remained unclear.

Similar to the taste and texture research, past research also suggests that smokers trying to reduce their harms from smoking are more likely to choose cigarettes with lower strength as defined by listed tar and/or nicotine levels or by the cigarettes being labelled as light, mild or low,[24] and their levels of misperception about light/low cigarettes being less harmful tend to correspond to the listed strength of the cigarettes they smoke - highest among smokers of 'ultralight' cigarettes and lowest among smokers of 'regular full-flavoured' cigarettes.[22] However, no past studies have examined whether the removal of nicotine and tar numbers or 'light/low' terms from cigarette packs and ads might have a differential impact on smoker misperceptions depending on whether they smoke cigarettes formerly labelled or advertised as light/low or with lower tar or nicotine numbers or that the smokers currently perceive as light/low despite the absence of the related numbers or descriptors. One would expect the impact to be greater for smokers of those light/low cigarettes that were most directly affected by the descriptor ban than for smokers of regular cigarettes.

Since 2006, there appear to have been only two major national policy changes in the US that may have influenced smokers' sensory and relative-harm beliefs: the previously described FTC guidance prompting cigarette companies to quickly remove nicotine and tar numbers from cigarette packs and advertising[25]; and the FSPTCA defacto ban on descriptors such as "light," "mild," and "low," with the cigarette companies' corresponding use of pack colours and colour terms and other descriptors to distinguish different brand variants. At the same time, recent evidence suggests no significant change in the filter ventilation levels of major brands and variants following the descriptor ban in the US.[3] Although it has not previously been researched, one would, therefore, anticipate that after the ban, smokers would become more reliant on package colours as an indicator of taste and texture, tar levels, whether a brand or variant was light/low or regular, and, consequently, relative harmfulness.

In the months leading up to the effective date of the FSPTCA ban on specific descriptor terms on existing cigarette packs, Philip Morris USA ran an information campaign for its leading brand Marlboro, and briefly introduced a pack insert to reassure consumers that their cigarettes remained the same despite the changed packaging (the only manufacturer known to do so), although the FDA quickly stopped this practice.[26] It is unclear how the information campaign might have differentially affected Marlboro smokers' misperceptions about the relative harmfulness of different cigarette variants. Marlboro has been heavily advertised and marketed in the US and remains the most popular brand smoked by US smokers.[27, 28]

This study extends previous research by Yong et al[7] using two additional waves of data from the US arm of the ITC Four-Country (ITC4) survey, collected in 2010 and 2013, to understand the impact following the 2009 removal of tar and nicotine numbers from packs and

advertisements and the 2010 defacto 'light/low' descriptor ban on US smokers' beliefs, reported experiences and perceptions about different styles of cigarettes. Specifically, this study examined (1) the extent to which the removal of misleading 'light/mild/low' terms from cigarette packaging affected (a) smokers' beliefs about the relative harmfulness of different cigarette variants; (b) their experiences about smoothness and taste of different variants; or (c) their perceptions about the extent to which pack colour, tar/nicotine levels, and pack descriptor like "smooth" provide useful information about cigarette taste or smoothness; and (2) the extent to which any impacts varied by cigarette brand (Marlboro vs other top-selling brands) and strength styles (ultralight, light, and regular cigarettes).

METHODS

Sample

Data come from US arm of the ITC4 project, a cohort study of adult smokers conducted annually since 2002 in the US, Canada, the UK and Australia. A detailed description of the conceptual framework and methods of the ITC-4 Survey has been reported elsewhere.[29, 30] Briefly, the ITC-4 Survey employs a prospective multi-country cohort design and involves telephone surveys of representative cohorts of adult smokers in each country using random-digit dialling (and from Wave 7 onwards web survey was also used). The sample size per country was initially around 2,000 at each wave, with replenishment sampling from the same sampling frame used to maintain sample size across waves (NB. A slightly reduced sample size was obtained at Waves 7 and 8, mainly due to budget, but the Wave 9 sample size was markedly increased through replenishment because of additional funding resources). A brief time-line of the data collection and key events related to the 'light/low' labelling change in the US is presented in Appendix, Supplemental Table 1. At the time of initial recruitment,

participants were aged 18+ years, had smoked at least 100 cigarettes over their lifetime, and had smoked at least once in the past 30 days.

Measures

Outcome measures: These included beliefs, experiences and perceptions about "light/low" cigarettes, and one's own brands, relating to relative harmfulness, cigarette taste, and taste indicators (see details in Table 1). Consistent with existing research[7], the 'Lights are less harmful' and 'Lights give less tar' belief items were combined into a scale (correlation across waves: r = 0.50–0.60, all p< 0.001) by averaging the scores to form the Lights Benefit Scale (LBS). Reported usual brand and sub-brand style smoked was recorded and used to determine brand family. The reported usual sub-brand style smoked was categorized as 'full flavor/regular', 'light', or 'ultralight' based on how the sub-brand style was labeled prior to the descriptor ban or on its current color coding, with those that could not be classified because of insufficient information coded as 'other'. Strength coding was based on Cornelius et al [31] and guided by our US investigators. For those without a usual brand and variant, last purchase brand and variant was used.

Covariates: These included cigarettes per day and having made a quit attempt in the prior year, as well as socio-demographics such as age, gender, annual household income (low: <=$29,999; moderate: $30,000-59,999; high: $>=$60,000), education (low: <=high school; moderate: some college/tech/trade school, no degree; high: university degree or higher), and minority ethnic status (non-white and mixed race versus white). Survey mode (phone vs internet) and cohort (i.e., year of recruitment) were also included.

Data analysis

All analyses were conducted using Stata version 14. Analyses were limited to current smokers of factory-made cigarettes at each wave with sufficient data to determine brand family and the cigarette strengths of the sub-brands or brand variants smoked (about 16% were excluded because of insufficient detailed brand attribute information provided). As the number of brand families and varieties was extensive and varied across waves, brand family analyses were limited to the top 10 brands reported at each wave, which included Marlboro, Newport, Camel, Doral, Winston, Kool, Basic, Virginia Slims, Salem, Benson & Hedges, Misty, Pall Mall, Seneca, American Spirit, Maverick, and Pyramid (list and ranking of specific brands vary across waves). This approach captured the top-selling brands (i.e., 73% to 80% of brands smoked by respondents across waves) while ensuring sufficient sample sizes for analyses. Marlboro was kept as a separate category for brand smoked comparisons because it was consistently the top brand (i.e., reported by 26-37% of the sample across the waves) and thus, study findings will be directly applicable to the largest share of current smokers in the US. The remaining brands were combined into a single category.

Estimates of means and proportions were computed on weighted data. In order to take into account the correlated nature of the longitudinal data, we used generalized estimating equations (GEE) to compute parameter estimates. A strength of GEE is that it allows cases with at least one wave of data to be included in analyses, thus allowing inclusion of data from replenishment samples, which helps minimize attrition bias. We assumed an unstructured working correlation structure given the large sample and used robust variance to compute the *P*-values for the parameter estimates. We tested for significant main effects of survey wave to assess change over time (both linear and quadratic trends, and also pre-post differences using simple contrast) in outcomes of interest. We also tested for significant interactions between wave and potential

moderators, such as brand or strength-style smoked to assess whether the patterns of change over time in outcomes of interest differed between smokers of Marlboro versus other top-selling brands combined and between smokers of different strength styles. In all models, we included the following invariant control variables (gender, minority status and year of recruitment) and time-varying covariates (age, education, income, cigarettes per day, any recent quit attempts, and survey mode).

RESULTS

Sample characteristics

Baseline sample characteristics are presented in Table 2. Over half of respondents were women, with the majority being white and nearly 70% aged 40 years and above. Nearly 60% had at least some college education, and nearly 60% reported having annual household income of >=$30,000 per year. Slightly more than one-third reported smoking 10 or fewer cigarettes a day.

Cigarette variant relative harm beliefs before and after the ban

Figure 1 shows the patterns of change over time in mean level of endorsement of lights beliefs and Table 3 presents the GEE results testing for main and interaction effects. Measures of misperceptions about lights cigarettes (both individual belief items and their combined scale) showed a decline between 2002 and 2005 (significant linear trend) and then a resurgence after 2006 before plateauing (significant quadratic trend) through 2013, with no clear effect of the ban on ‘light/low’ descriptors (non-significant pre-post ban effect). As expected, the overall level of endorsement of the beliefs about light cigarettes differed by brand strength style, being

highest among ‘ultralight’ smokers and lowest among ‘regular full-flavoured’ smokers (p<.001). However, overall level of endorsement of these beliefs was lower among Marlboro smokers than among those who smoked other top-selling brands (all differences significant at p<.01). Overall endorsement of the belief that one’s own brand is less harmful than others remained stable between 2007 and 2013 although significant differences between strength styles (p<.001) but not between Marlboro and other top brands smoked (p=.439) were observed. Also, differences between strength styles showed narrowing post-ban (a significant year by strength interaction [p<.001], Figure 1B) but such pattern of change did not differ by brand smoked (year x strength x brand interaction not significant). More than 3 years post-implementation of the light/low descriptor ban, 12% of current smokers still mistakenly reported that their own brands of cigarettes were less harmful than other brands.

Cigarette variant sensory beliefs/experiences before and after the ban

GEE results (Table 3) revealed that overall endorsement of lights cigarettes being smoother on the throat and chest showed a gradual decline over time between 2002 and 2006, but recovered somewhat by 2007 before plateauing (53.8% endorsing this belief in 2013) with no clear effect of the 2010 ban (Supplementary Figure 2A), although the pre-ban mean endorsement was significantly higher than that of post-ban (p=.038). Notably, the pattern of changes in this belief was similar across the different cigarette strength styles (regardless of brand) although the overall level differed by strength styles, being highest among ‘ultralight’ smokers and lowest among ‘regular full-flavour’ smokers (p<.001). However, no overall differences in responses or in overall trends over time by brand smoked were observed. The trends by strength styles also did not differ by brand smoked.

Reported endorsement of one's own brand being lighter in taste assessed between 2007 and 2013 indicated that the initial decline between 2007 and 2008 was not sustained but increased (42.1% endorsement in 2013) after the policy change, with a greater increase among 'light' smokers than among 'ultralight' and 'regular' smokers (year by strength interaction significant at p=.013, see Supplementary Figure 2B). The pattern of change for believing one's own brand is smoother on the throat (with 59% endorsing it in 2013) was very similar to that of believing one's own brand is lighter in taste but the trends did not differ by strength styles (Supplementary Figure 2C). For both measures of sensory effects of their cigarettes, no significant differences by brand smoked were observed and the trends by strength styles also did not differ by brand smoked.

Cigarette variant taste indicators before and after the ban

GEE results (Table 3) showed that the trend in reported utility of pack colour as an indicator of taste differed by strength styles (p=.004). Reporting pack colour as an indicator of taste remained stable for regular smokers throughout the study period (36.3% reporting it in 2013). However, for both 'ultra' and 'light' smokers, endorsement of this taste indicator showed an initial decline between 2007 and 2008 and then an increase (with 37.9% and 45.3%, respectively, reporting it in 2013) following the 2010 ban on 'light/low' descriptors (significant quadratic trend, see Supplementary Figure 3A).

The perception that nicotine and tar levels are useful indicators of taste showed a similar initial decline followed by an increase after the removal of tar/nicotine numbers in 2009 and the descriptor ban in 2010 (with 51.4% perceiving this in 2013) but this trend did not differ by

strength styles (see Supplementary Figure 3B). The pattern of change also did not differ by brand smoked. However, there was a clear overall difference by strength styles (p=.004) with 'ultralight' smokers being more likely to perceive nicotine and tar levels as useful taste indicators than regular smokers, with no difference between 'light' and regular smokers.

Perceiving the term "smooth" on pack as indicating that the cigarette is a 'light/low' cigarette showed an increase between 2005 and 2007 and subsequently plateaued over the remainder of the study period (Supplementary Figure 3C, significant quadratic trend; 34.1% perceiving this in 2010) with no clear differences by strength styles in either mean level of endorsement or pattern of change over time (Table 3).

For all three measures of taste indicator perceptions, there was no evidence of a significant difference in either overall level or pattern of change between Marlboro smokers and the smokers of other brands.

DISCUSSION

Consistent with findings in Australia, and the UK[6, 7], this study confirms that the removal of misleading terms such as 'light', 'mild' and 'low' in the US, even after tar and nicotine numbers had already been removed from packs and advertising, had little impact on changing consumer misperceptions that some cigarettes are less harmful than others. A non-trivial number of current smokers (12%, which roughly translates to 5 million smokers nationwide) still reported that their own cigarette brands were less harmful than others. Also consistent with other observational studies[3, 9], this study shows that following the ban, smokers have increasingly

relied on pack colours, colour terms, and other descriptors (e.g., 'smooth'), as well as sensory experiences of smoother or lighter taste, to help identify their preferred cigarette brand styles and determine which brand styles are light versus regular cigarettes. Hence, the descriptor ban does not appear to have advanced the objective of eliminating smoker misperceptions that some cigarette sub-brands or variants – including those previously labelled and marketed as light, mild or low -- are less harmful than others (which may lead some to smoke brands or styles they mistakenly think are less harmful instead of trying to quit smoking).

Consistent with the trend reported in Yong et al[7], this study shows that misperceptions about 'light' cigarettes among current smokers declined from a high level in 2002 to a low but still significant level in 2006. This decline was possibly due to increased public awareness and understanding of the lights deception that were highlighted in several high-profile court cases about the lights fraud in the US. By 2007, as the issue waned, misperceptions started to trend up and plateau showing little change following the 2009 removal of tar and nicotine numbers or the 2010 descriptor ban. The findings suggest that the removal of the numbers and descriptors from cigarette packs and ads had no observable impact on misperceptions. This is not surprising for two reasons. First, the policy changes were not accompanied by any public education campaign or wide media coverage in the US, the most plausible driver of change in countries like Australia and the UK that had implemented similar descriptor bans[6, 7]. Second, the policy did not address other interrelated cues used by smokers as indicators of risk, including colours, colour words and other descriptors (e.g., "smooth"), perceived taste or smoothness, and design features, which have been shown in past research to be potent conveyors of reduced-risk messages.[3, 9-11, 32] This study's observed increase in the perceived utility of various indicators of cigarette taste and reported sensory experiences of smoothness

and/or lightness of cigarettes further supports the role of these other cues in supporting smokers' reduced-risk beliefs.

This study also confirms that the levels of misperceptions correspond to cigarette strength-style levels in a dose-response manner (highest among smokers of 'ultralight' cigarettes and lowest among smokers of 'regular' cigarettes), as found previously.[6, 22] One interesting finding is the narrowing of the differences in misperceptions between smokers of different strength styles but only for beliefs about the harmfulness of one's own cigarettes. It remains unclear to what extent the narrowing was due to the two policy changes as other related measures did not change in this way, as we might expect if the policy changes had any positive effect in reducing misperceptions. Whether this effect or the others will be sustained over time is unclear.

The additional data available from this study show that the declining trend in the belief that 'light' cigarettes are smoother than regular cigarettes reported by Borland et al[6] was not sustained over time as the level of this sensory belief remained relatively stable in recent years with little change following the descriptor ban. However, of concern is the upward trend observed post-ban on more recent measures of smokers' comparative experiences of lightness and smoothness of their own brand as compared to others (reported by 42% and 59%, respectively, in 2013), although the reason for this uptick is unclear. Nevertheless, our data show a clear correspondence between strength-style of cigarettes and their reported sensory effects, suggesting that the design features of cigarettes -- in particular filter ventilation[33] but also including known and perceived historical labelling as well as current colour coding, colouring, colour terms and other descriptors -- will continue to produce and reinforce smoker

misperceptions of product characteristics and product safety[10] regardless of how these brand variant differences are described.[34]

This study also shows that a significant number of smokers (as high as one in two), across all strength styles and irrespective of brand family, appear to have come to understand that, post ban, they can use pack colour, colour terms, and other descriptors such as "smooth" to identify cigarettes they mistakenly believe to be less harmful/risky. The significantly greater use of nicotine and tar yield information among 'ultralight' smokers (presumably through colour coding and other proxies following the removal of tar numbers) is consistent with the manufacturer's more common use of such numbers on these brand variants and in their advertising in the past. Indeed, following the descriptor ban colour has become a key visual signifier differentiating one variant from another and the reliance on this strategy post-ban is what was helping to maintain the misperceptions about product risks among US consumers.[3, 9, 11, 14, 15]

Data from this study did not reveal any clear evidence of trend differences in beliefs, experiences and perceptions about different cigarettes between the dominant brand Marlboro and the other top-selling brands. This finding is rather surprising given the known efforts made by PM USA just prior to the ban to educate consumers (via pack inserts and onserts) on how to identify particular brands/sub-brands based on new colour coding.[3, 11] Nevertheless, the overall level of misperceptions was significantly lower among Marlboro smokers than that among smokers of other top-selling brands, possibly due to the effect of the information campaigns by PM USA to inform its customers via pack inserts that lights cigarettes are not

less dangerous as part of their efforts to mitigate the negative impacts of the publicity surrounding the court cases regarding the lights deception.[35]

A few study limitations warrant some discussion. First, effects found may be underestimated due to the use of self-report data which may be affected by social desirability biases (e.g., the discussion of equivalent harmfulness of so-called 'light' cigarettes might have inhibited some people's preparedness to report differences) and/or misclassification errors. Second, our sample excluded those with missing data on brand and brand varieties which could limit the generalizability of our findings. Third, our study only evaluated the relatively short-term impact of the descriptor ban. Longer term trend and impact analyses await future study. That said, it seems unlikely that differences will emerge with time, unless the ban has a much larger influence on those taking up smoking than it has had on existing smokers, and we can see no good reason why that might happen. Because of limitations inherent in the survey questions and answers, this study was also unable to determine what, exactly, smokers meant when they reported that the cigarettes they smoked were less harmful than others. Further research would be needed to identify which specific brands, variants or types of cigarettes those smokers think are more harmful (e.g., other variants of the same brand, other brands of the same variant, other strength styles, or possibly some other specific cigarette brand they think are the most harmful).

In conclusion, this study confirms that the removal of 'light', 'mild' and 'low' descriptors from cigarette packaging and advertising pursuant to the related ban in the Tobacco Control Act – following the removal of nicotine and tar numbers from cigarette packs and ads -- has not corrected consumers' misperceptions that some cigarettes are safer than others. The defacto light/low descriptor ban in the USA has also led to an increase in the number of consumers

who report relying upon on other brand descriptors (e.g., smooth) and other features of the package and product to differentiate brands by (inaccurately) perceived differences in harmfulness. These findings provide further support for FDA action to remove the elements of product packaging and engineering (such as colour coding and the descriptor “smooth”) that contribute to consumer misperceptions regarding product risk or to enforce against manufacturers marketing cigarettes with those misleading elements. The existing FSPTCA clearly prohibits manufacturers from having misleading labeling or ads or making explicit or implicit reduced-risk or reduced-exposure claims about any cigarette brand or sub-brand unless the claims are not false or misleading and the manufacturer has first obtained a modified risk tobacco product order from FDA. These findings also support the introduction of standardized packaging and other standardized product characteristics, including the regulation of product engineering such as filter ventilation, as additional strategies to help minimise consumer misperceptions that some cigarettes are safer, which can delay or prevent smoking cessation.

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Ethical Approval:

All waves of the ITC US study have received ethical approval from the relevant research ethics committee at the Medical University of South Carolina, USA and Roswell Park Cancer Institute, USA.

Declaration of interests:

Dr. Cummings has received grant funding from Pfizer, Inc. to study the impact of a hospital based tobacco cessation intervention and also has served as an expert witness in litigation filed against the tobacco industry. Mr Lindblom is a former Director of the Office of Policy at Food and Drug Administration's Center for Tobacco Products but Mr. Lindblom's participation in this paper is entirely independent of his FDA affiliation. Dr O'Connor has served as a consultant to the FDA on tobacco regulation as a member of the Tobacco Products Scientific Advisory Committee. Drs. Thrasher and Hammond have both received

payment as an expert witness in litigation involving the tobacco industry. All other authors have no conflicts of interest to declare.

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Table 1. Light/mild/low related questions assessed in the ITC US survey.

Survey questions	**Wave (year) asked**	**Response options**
Beliefs		
Light cigarettes are less harmful than regular cigarettes. Smokers of light cigarettes take in less tar than smokers of regular cigarettes.	1 to 8 (2002-2010)	rated on a 5-point scale ranging from 'strongly agree' to 'strongly disagree' (NB. Responses were reversed coded and 'Don't Know' responses recoded as 'neither' for analysis purpose)
Based on your experience of smoking, do you think that the brand you usually smoke, [regular brand], might be a little less harmful, no different, or a little more harmful, compared to other cigarette brands?	5 to 9 (2006-2013)	'a little less harmful', 'no different', 'a little more harmful', or 'Don't Know' (NB. Responses were reversed coded and 'Don't Know' responses recoded as 'no different' for analysis purpose)
Experiences		
Light cigarettes are smoother on your throat and chest than regular cigarettes.	1 to 8 (2002-2010)	rated on a 5-point scale ranging from 'strongly agree' to 'strongly disagree' (NB. Responses were reversed coded and 'Don't Know' responses recoded as 'neither' for analysis purpose)
Thinking about the cigarettes you are currently smoking in relation to other cigarettes, are your cigarettes . . .: Lighter in taste or more intense in taste? Harsher or smoother on your throat?	6 to 9 (2007-2013)	'lighter', 'about the same', 'more intense', or 'Don't Know'; and 'harsher', 'about the same', 'smoother', or 'Don't Know', respectively. (NB. Responses were reversed coded and 'Don't Know' responses recoded as 'about the same' for analysis purpose)
Perceptions		
To what extent do any of the following give you useful information on how cigarettes will taste: The colours of the pack itself? The tar and nicotine levels of the brand?	6 to 9 (2007-2013)	'not at all', 'a little', 'somewhat', 'a lot', or 'Don't Know' (NB. Being an ordinal scale, 'Don't Know' responses were deemed to be situated somewhere between 'not at all' and 'a little', thus, they were recoded as 'a little' for analysis purpose)

Does the term SMOOTH on cigarette packs mean that the cigarettes are supposed to be some form of light, mild, or low-tar cigarette?	4 to 8 (2005-2010)	'Yes', 'No', or 'Don't Know' (NB. 'Don't Know' responses were recoded as 'No' for analysis purpose)

Table 2. Baseline characteristics of International Tobacco Control USA sample, 2002-2013 (n=7,072)#

Age in years (%)	
18-24	15.0
25-39	15.6
40-54	37.1
55+	32.3
Gender (% female)	56.2
Identified minority group (%)	19.8
Education (%)	
Low	42.1
Moderate	40.1
High	17.8
Income (%)	
Low	34.8
Moderate	32.2
High	26.5
No information	5.5
Cigarettes per day (%)	
1-10	35.2
11-20	45.7
21-30	12.0
31+	7.1
Wave (Year) of recruitment (n)	
Wave 1 (2002)	2,013
Wave 2 (2003)	637

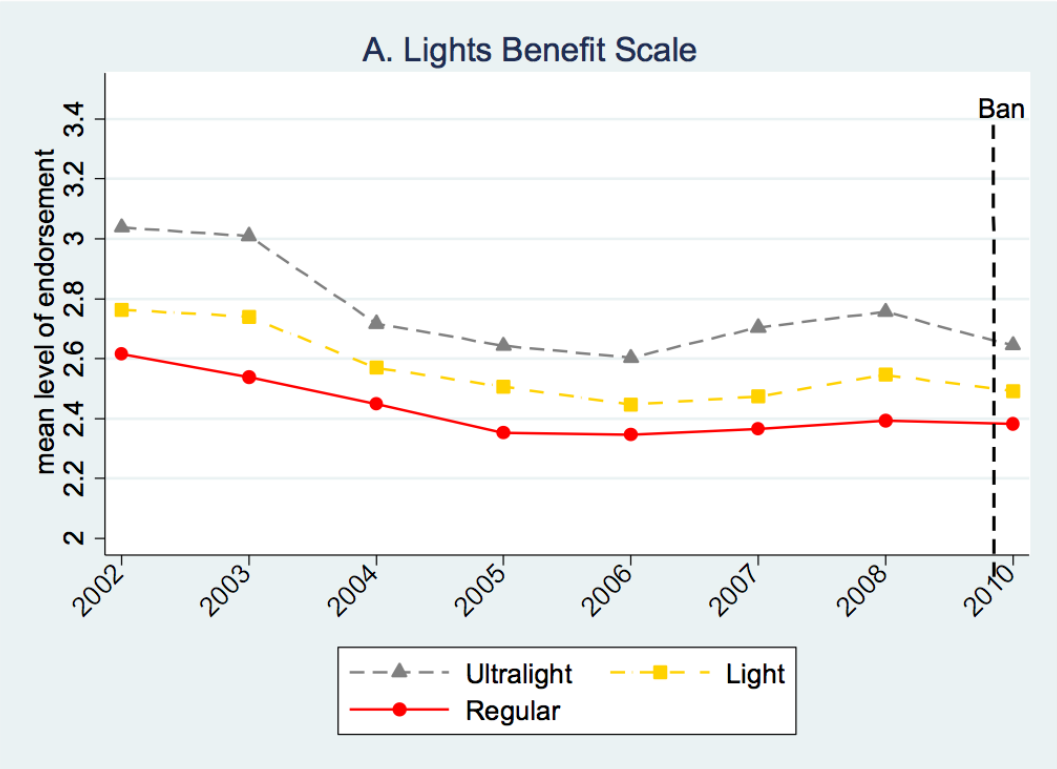
Wave 3 (2004)	856
Wave 4 (2005)	687
Wave 5 (2006)	537
Wave 6 (2007)	501
Wave 7 (2008)	294
Wave 8 (2010)	271
Wave 9 (2013)	1,276

NB. Percentages are based on unweighted data;
Among current factory-made cigarette smokers with data on cigarette brand attribute;

Table 3. Beliefs, reported experiences and perceptions of top-selling cigarette brand variants in the US: Results from GEE modelling.

Outcomes	n (N)	Survey Year (Wave)					Trend analysis			Strength style			Brand smoked
		2007 (w6)	2008 (w7)	2010 (w8)	2013 (w9)	Overall p-value	linear	quadratic	Pre vs Post-ban	Ultra vs Regular	Light vs Regular	Overall p-value	Marlboro vs Other
Beliefs:													
Lights less harmful†	5,879 (10,573)	-.08 (.04)	Ref	-.02 (.06)	--	<.001	**-.17** [c] (.03)	**.02** [c] (.00)	-.11 (.08)	**.42** [c] (.04)	**.16** [c] (.03)	<.001	**-.11** [c] (.03)
Lights less tar†	5,878 (10,569)	-.04 (.05)	Ref	-.02 (.06)	--	<.001	**-.13** [c] (.03)	**.01** [a] (.00)	-.01 (.08)	**.31** [c] (.04)	**.10** [b] (.03)	<.001	**-.08** [a] (.03)
Lights benefit scale†	5,878 (10,567)	-.06 (.04)	Ref	-.02 (.06)	--	<.001	**-.15** [c] (.02)	**.01** [c] (.00)	-.05 (.07)	**.35** [c] (.04)	**.13** [c] (.03)	<.001	**-.10** [c] (.03)
Own cigs less harmful#*	3,027 (4,611)	-.01 (.03)	Ref	-.02 (.03)	-.00 (.03)	.890	-.00 (.15)	.00 (.01)	-.03 (.05)	**.41** [c] (.03)	**.24** [c] (.02)	<.001	-.02 (.02)
Experiences:													
Lights smoother†	5,879 (10,571)	.06 (.04)	Ref	-.05 (.07)	--	<.001	**-.13** [c] (.03)	**.01** [c] (.00)	**-.16** [a] (.08)	**.76** [c] (.03)	**.50** [c] (.03)	<.001	-.05 (.03)
Own cigs lighter* OR (95% CI)	3,026 (4,609)	**1.64** [c] (1.33-2.02)	Ref	1.04 (.79-1.37)	**1.94** [c] (1.43-2.64)	<.001	**.02** [c] (.00-.06)	**1.32** [c] (1.21-1.45)	0.97 (.65-1.46)	**16.73** [c] (12.42-22.52)	**6.26** [c] (5.20-7.55)	<.001	.88 (.73-1.06)
Own cigs smoother OR (95% CI)	3,025 (4,607)	**1.85** [c] (1.51-2.26)	Ref	1.11 (.87-1.43)	**2.42** [c] (1.77-3.29)	<.001	**.01** [c] (.00-.02)	**1.42** [c] (1.29-1.55)	1.03 (.71-1.49)	**3.87** [c] (2.96-5.06)	**1.99** [c] (1.67-2.38)	<.001	.89 (.74-1.07)
Perceptions:													
Pack colour*													
B (SE)	3,030 (4,615)	**.10** [a] (.05)	Ref	.07 (.06)	**.23** [b] (.07)	.003	**-.94** [c] (.27)	**.06** [c] (.02)	.05 (.08)	.01 (.06)	-.00 (.04)	.970	.03 (.04)
Nicotine & tar levels													
B (SE)	3,022 (4,606)	**.11** [a] (.04)	Ref	**.13** [a] (.05)	**.25** [c] (.07)	.001	**-.86** [b] (.27)	**.06** [b] (.02)	.12 (.08)	**.18** [b] (.06)	.02 (.04)	.004	.01 (.04)
Term 'smooth'†													
OR (95% CI)	3,394 (6,026)	**1.39** [c] (1.13-1.69)	Ref	1.25 (.99-1.59)	--	<.001	**5.51** [c] (2.53-11.98)	**.87** [c] (.81-.93)	**1.72** [a] (1.11-2.64)	.99 (.78-1.27)	1.13 (.97-1.33)	.237	.88 (.75-1.04)

NB. GEE, generalised estimating equations; n, number of unique individual observations; N, number of person-wave observations;
B, regression estimates (positive coefficients refer to higher, while negative coefficients refer to lower, mean level of endorsement of each outcome relative to the reference group); SE, standard error;
OR, odds ratios; CI, confidence interval;
Ref, reference group (Survey year 2008, the most proximal year prior to the ban, was set as the reference group for comparison with other survey year); --, data not available as question not asked in that survey year;
[a] significant (in bold) at p<.05; [b] p<.01; [c] p<.001;
† Results for this outcome with data prior to survey year 2007 are not shown (available in Appendix);
# data analysed excluded wave 5 (i.e., only included waves 6 to 9) because of question order and skip pattern at wave 5 being different to that of subsequent waves;
* significant wave x strength interaction (p<.001, p=.018, and p=.004, respectively);



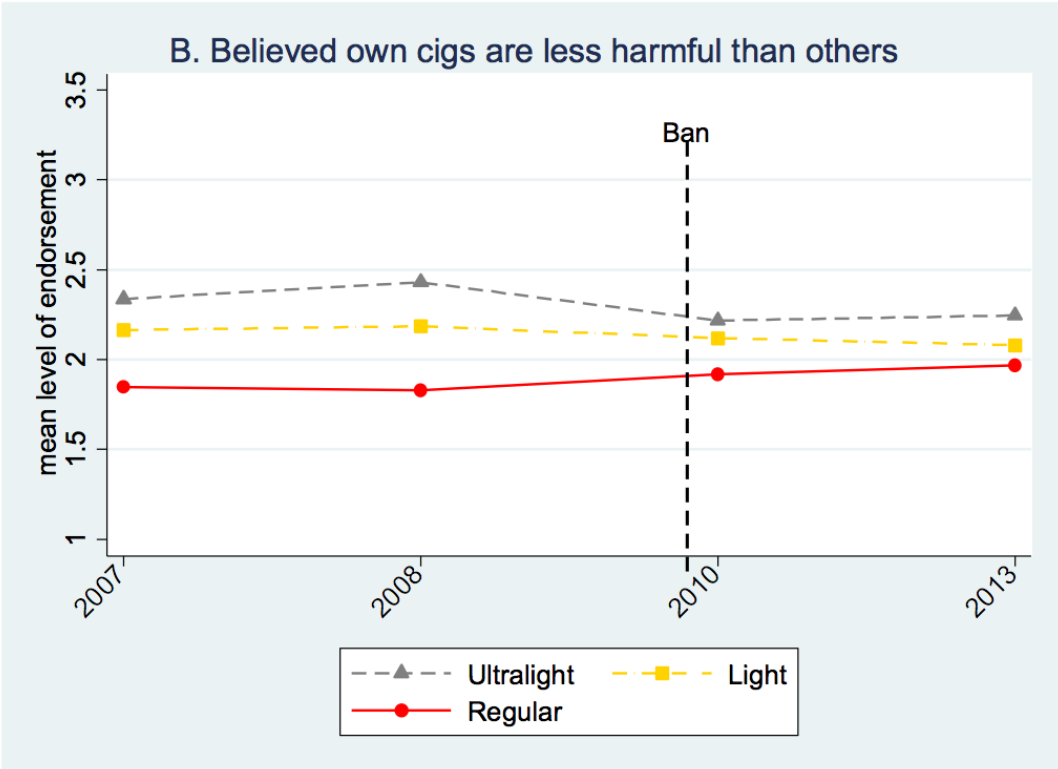


Figure 1 (A & B). Trends in belief about the health benefits of 'light' cigarettes and lower risk of one's own brand, before and after the implementation of the removal of 'light', 'mild' and 'low' descriptors in the United States. Weighted estimates adjusted for socio-demographic and smoking-related variables along with survey mode and year recruited into the survey.

APPENDICES

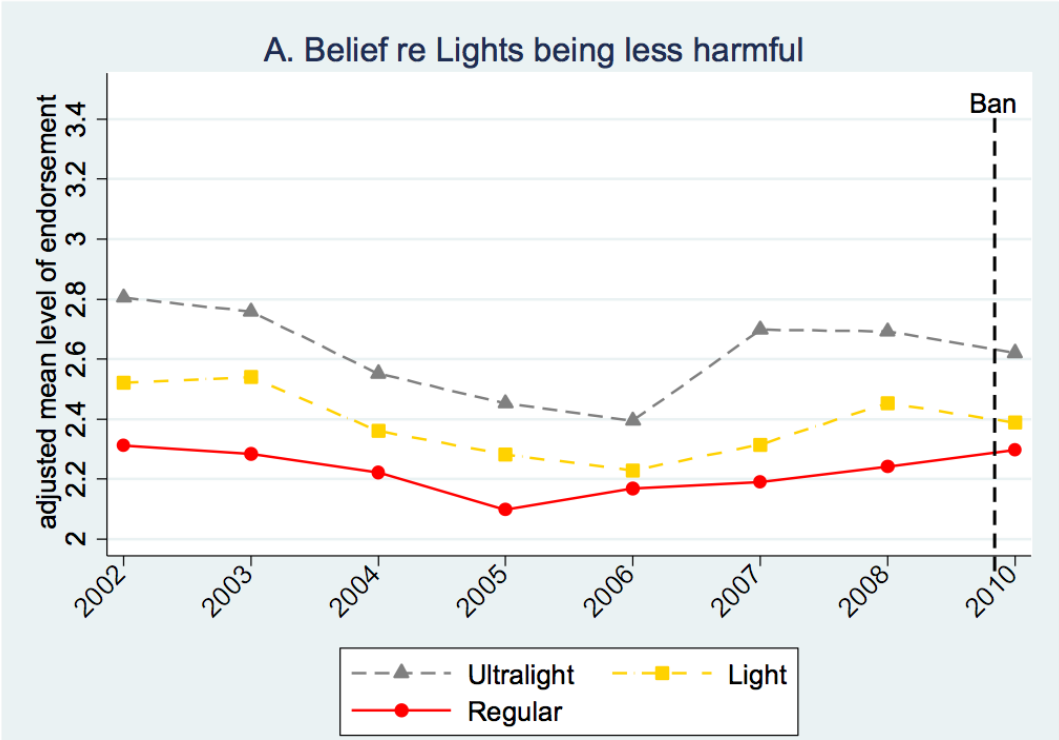
Supplementary Table 1. Timeline of key events and the ITC data collection period in the US

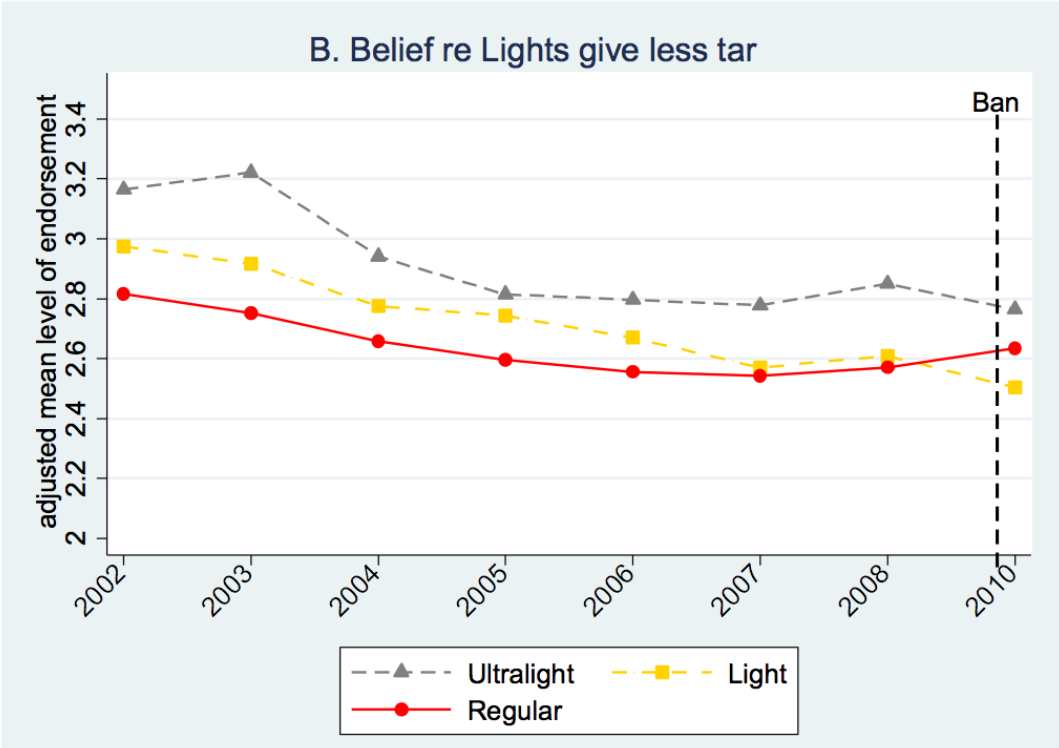
ITC US Data collection period and relevant key events pertaining to 'light/mild' cigarettes
Nov 2001: NCI Monograph 13 released, confirms no difference in risk between low-tar/Light and regular cigarettes.
Oct-Dec 2002: ITC Wave 1 data collection
Mar 2003: Philip Morris lost Light fraud class action suit in Illinois, & ordered to pay $10B in damages.
June-Aug 2003: ITC Wave 2 data collection
Aug 2004: Light fraud class action suit certification upheld in Massachusetts. Decision & publicity during Wave 3 survey.
June-Dec 2004: ITC Wave 3 data collection
Dec 2005: Illinois class action case and damages dismissed by Illinios Supreme Court, citing Federal pre-emption. US Supreme Court declines review.
Oct 2005-Jan 2006: ITC Wave 4 data collection
Aug 2006: Federal judge rules in US Department of Justice lawsuit that major tobacco companies misled the public re the health benefits of so-called 'light' cigarettes and ordered them to stop using such descriptors. Ruling remains under appeal.
Oct 2006-Feb 2007: ITC Wave 5 data collection
Sept 2007-Feb 2008: ITC Wave 6 data collection
Dec 2008: US Supreme Court rules that 'Light' cigarette lawsuits not pre-empted by the Federal Cigarette Labelling and Advertising Act of 1965.
Oct 2008-Feb 2009: ITC Wave 7 data collection
December 2008: Federal Trade Commission issued its notice rescinding its prior guidance that listing Cambridge method or "FTC method" nicotine and tar levels on packs and in advertisements was not a violation of the FTC Act, prompting cigarette companies to remove the tar/nicotine figures from their pack. June 22, 2009: US Congress passed the Tobacco Control Act, which included media coverage of its provisions banning 'light/mild/low' terms, effective June 2010. June 22, 2010: FDA banned the explicit or implicit use of descriptors such as 'light', 'mild' and 'low' on tobacco products or in advertising.
July 2010-June 2011: ITC Wave 8 data collection
Sept 2013-Jan 2014: ITC Wave 9 data collection

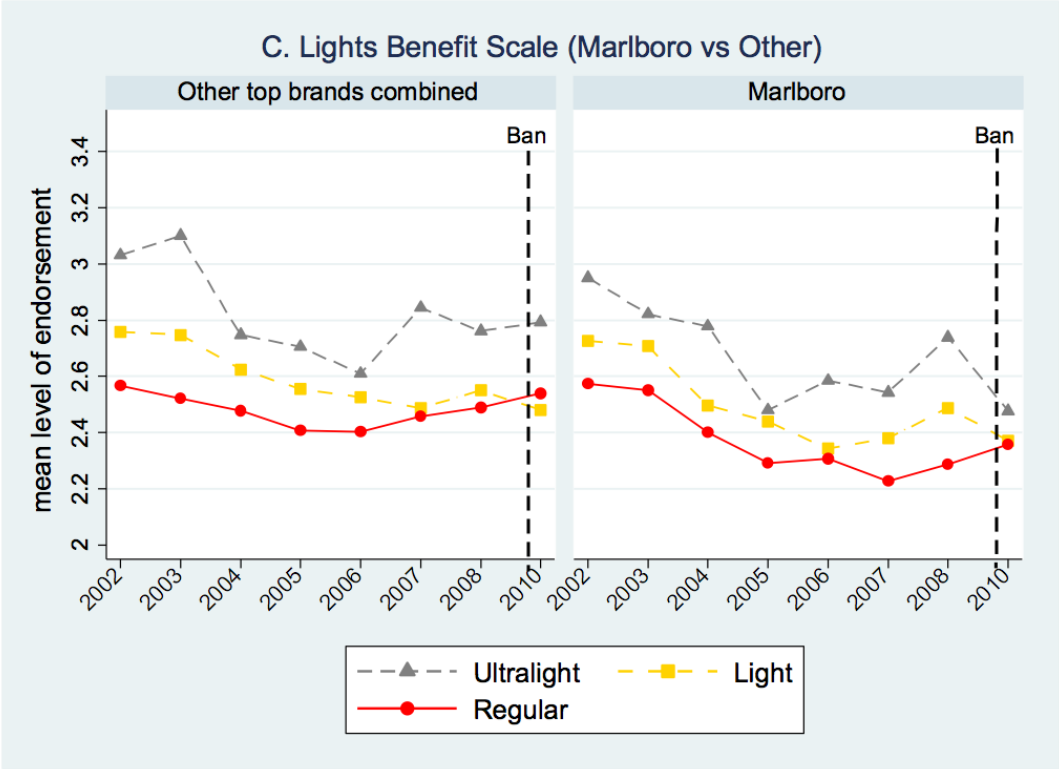
Supplementary Table 2. Beliefs, reported experiences and perceptions of top-selling cigarette brand variants in the US: Results from GEE modelling.

Outcomes	n (N)	Survey Year (Wave)								
		2002 (w1)	2003 (w2)	2004 (w3)	2005 (w4)	2006 (w5)	2007 (w6)	2008 (w7)	2010 (w8)	2013 (w9)
Beliefs:										
Lights less harmful										
B	5,879	.08	.08	-.07	**-.16** [b]	**-.17** [c]	-.08	Ref	-.02	--
(SE)	(10,573)	(.06)	(.06)	(.06)	(.05)	(.05)	(.04)		(.06)	
Lights less tar										
B	5,878	**.32** [c]	**.27** [c]	**.14** [a]	.07	.02	-.04	Ref	-.02	--
(SE)	(10,569)	(.06)	(.06)	(.06)	(.05)	(.05)	(.05)		(.06)	
Lights benefit scale										
B	5,878	**.20** [c]	**.18** [c]	.03	-.04	-.07	-.06	Ref	-.02	--
(SE)	(10,567)	(.05)	(.05)	(.05)	(.04)	(.04)	(.04)		(.06)	
Experiences:										
Lights smoother										
B	5,879	**.14** [a]	.03	.04	-.06	-.07	.06	Ref	-.05	--
(SE)	(10,571)	(.06)	(.06)	(.06)	(.05)	(.05)	(.04)		(.07)	
Perceptions:										
Term 'smooth'										
OR	3,394	--	--	--	**.66** [c]	.82	**1.39** [b]	Ref	1.25	--
(95% CI)	(6,026)				(.53-.83)	(.66-1.02)	(1.14-1.69)		(.99-1.59)	

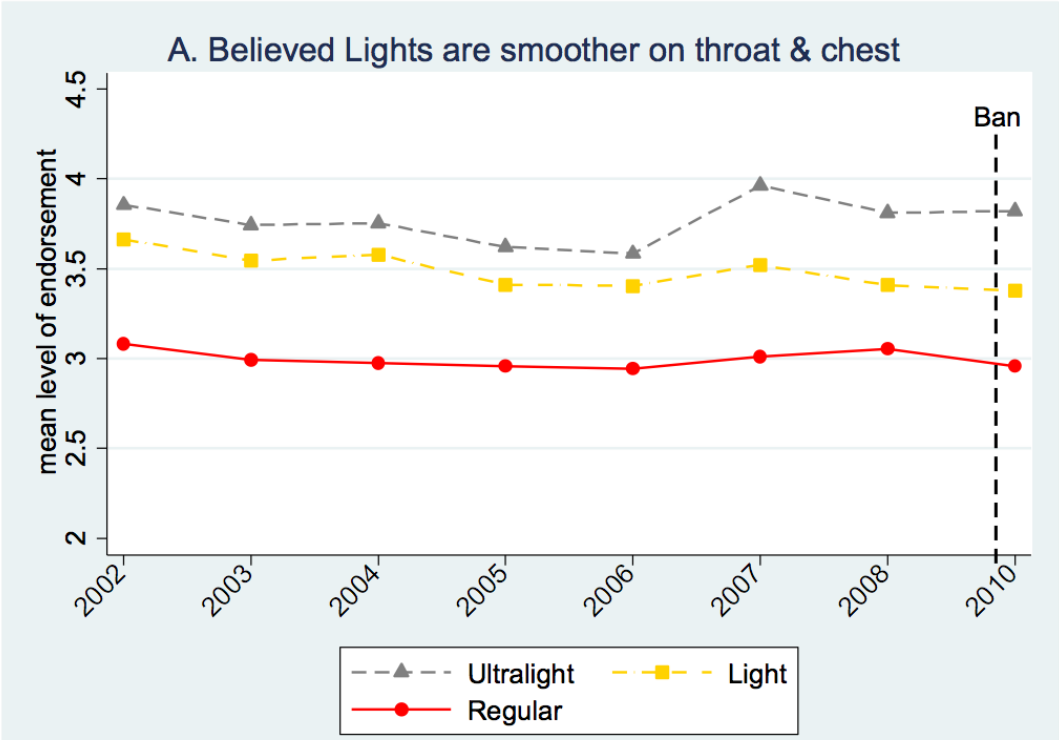
NB. GEE, generalised estimating equations; n, number of unique individual observations; N, number of person-wave observations;
B, regression estimates (positive coefficients refer to higher, while negative coefficients refer to lower, mean level of endorsement of each outcome relative to the reference group); SE, standard error;
OR, odds ratio; CI, confidence interval;
Ref, reference group (Survey year 2008, the most proximal year prior to the ban, was set as the reference group for comparison with other survey year);
--, data not available as question not asked in that survey year;
[a] significant (in bold) at p<.05; [b] p<.01; [c] p<.001;

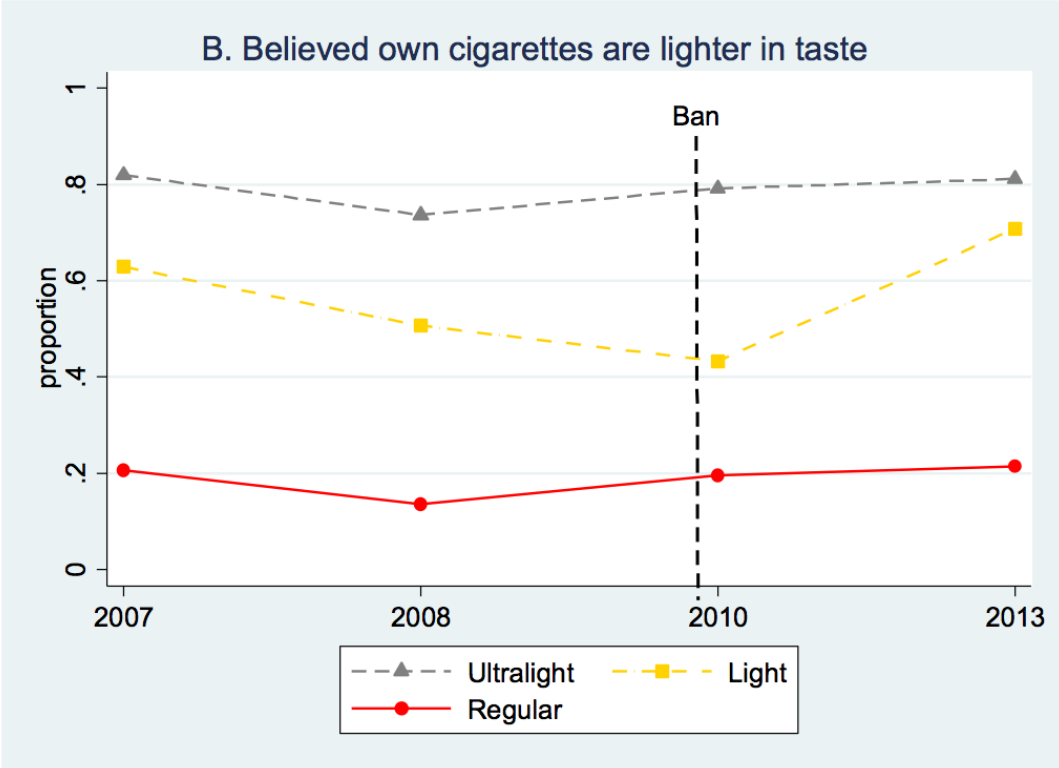

A. Belief re Lights being less harmful
adjusted mean level of endorsement
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Ban
2002
2003
2004
2005
2006
2007
2008
2010
Ultralight
Light
Regular

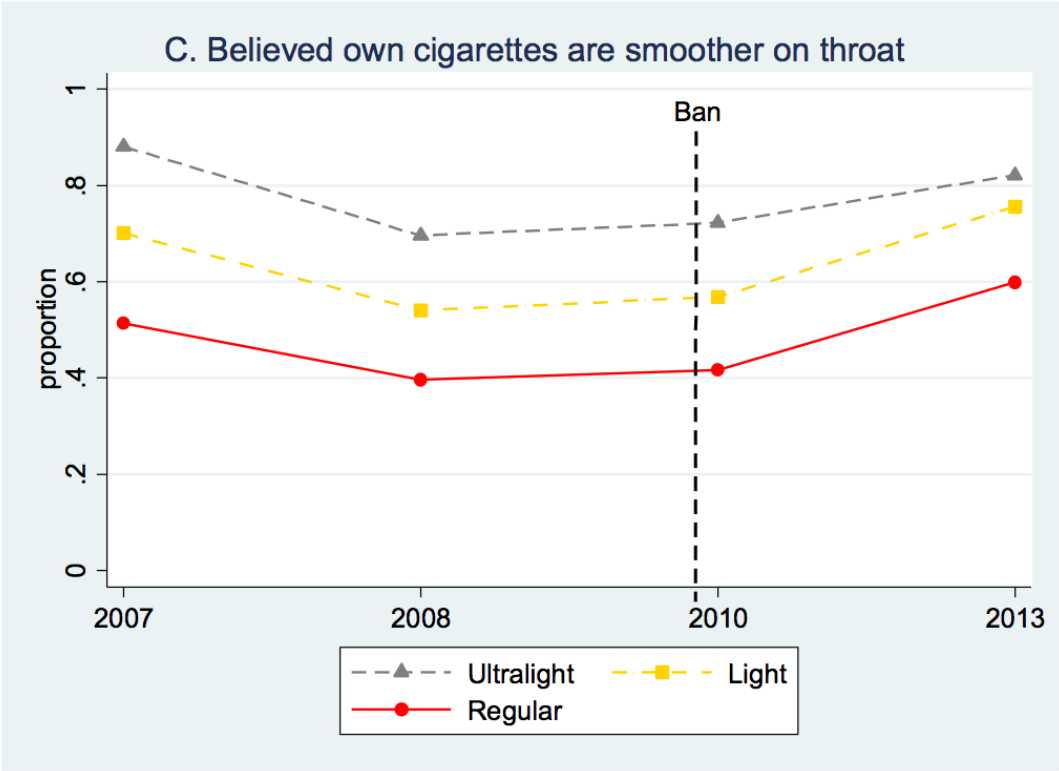

B. Belief re Lights give less tar
adjusted mean level of endorsement
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Ban
2002
2003
2004
2005
2006
2007
2008
2010
Ultralight
Light
Regular



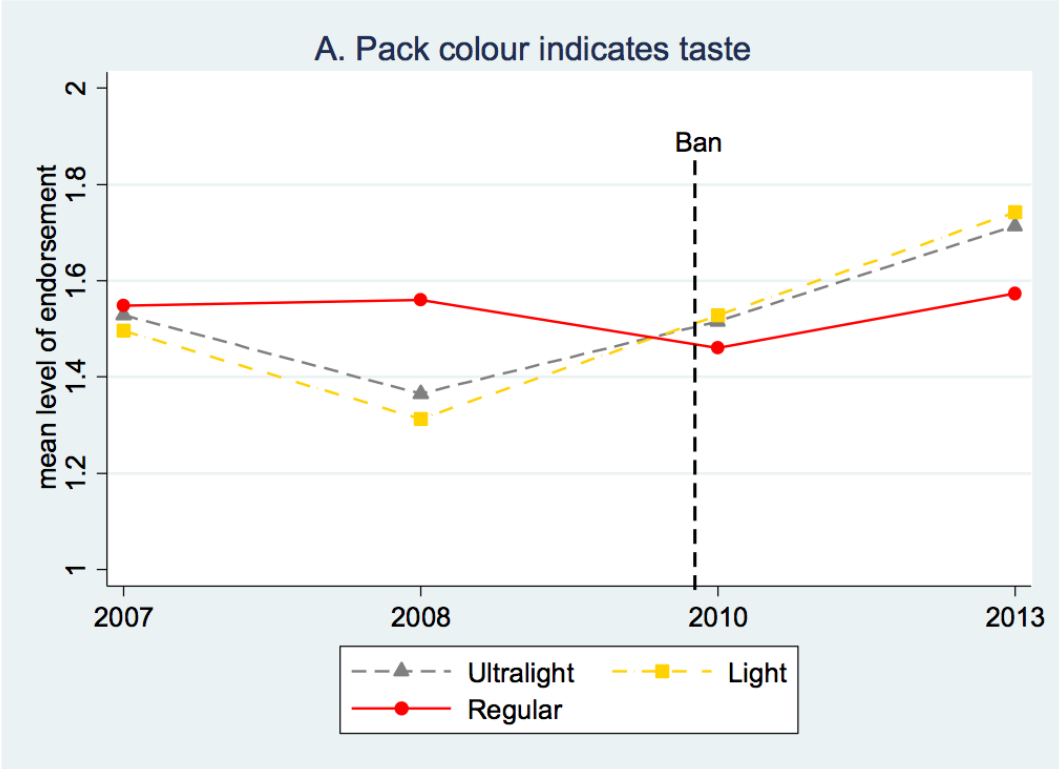
Supplementary Figure 1 (A, B & C). Trends in belief about 'light' cigarettes are less harmful, 'light' cigarettes give less tar, and Lights Benefit Scale stratified by Marlboro and other top brands combined, before and after the implementation of the removal of 'light', 'mild' and 'low' descriptors in the United States. Weighted estimates adjusted for socio-demographic and smoking-related variables along with survey mode and year recruited into the survey.

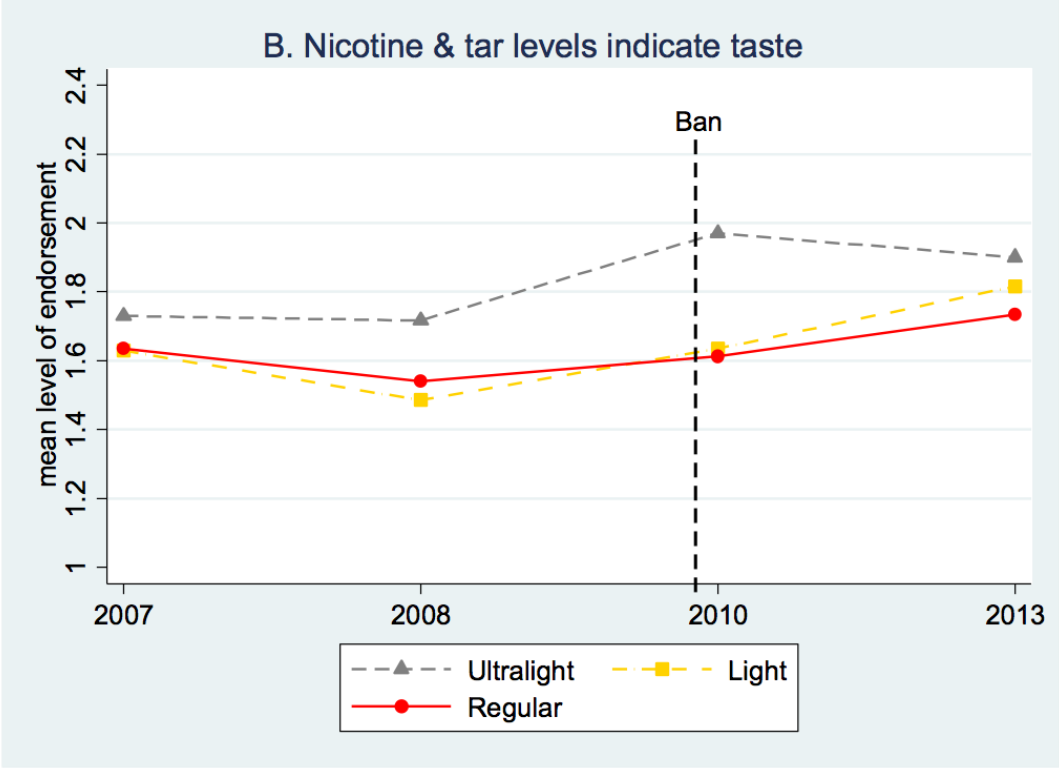

A. Believed Lights are smoother on throat & chest
mean level of endorsement
2
2.5
3
3.5
4
4.5
Ban
2002
2003
2004
2005
2006
2007
2008
2010
Ultralight
Light
Regular

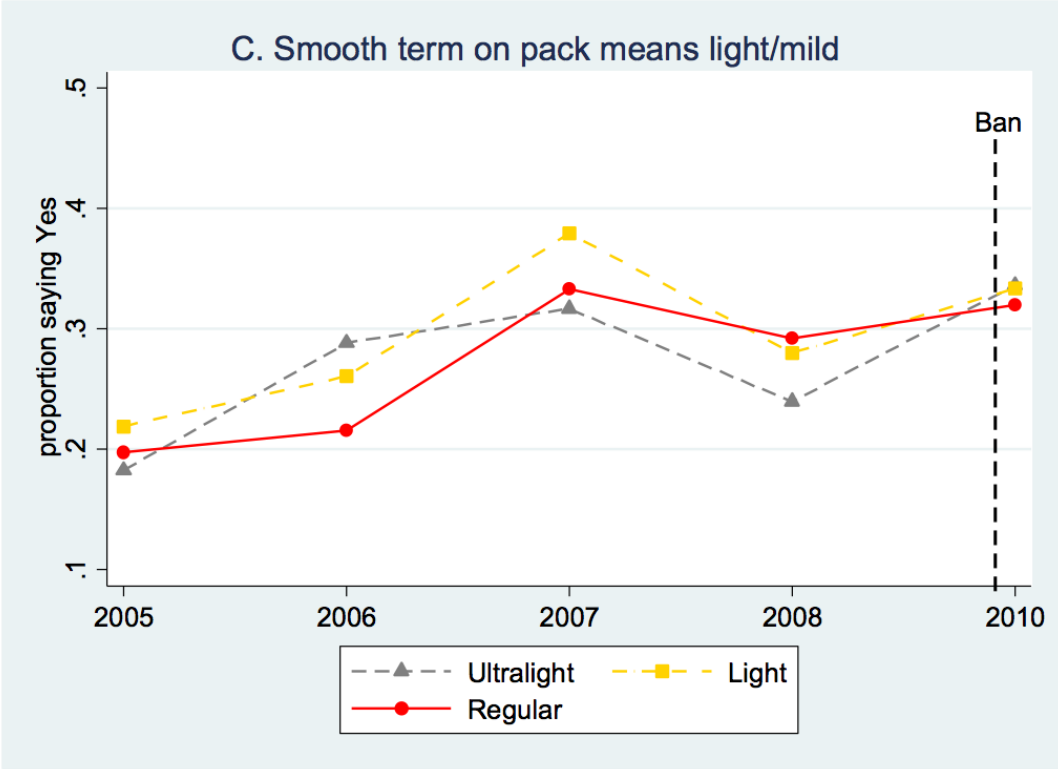

B. Believed own cigarettes are lighter in taste
proportion
0
.2
.4
.6
.8
1
Ban
2007
2008
2010
2013
Ultralight
Light
Regular



Supplementary Figure 2 (A, B & C). Trends in reported experiences of relative smoothness and lightness of different cigarettes. Weighted estimates adjusted for socio-demographic and smoking-related variables along with survey mode and year recruited into the survey.


A. Pack colour indicates taste
mean level of endorsement
1
1.2
1.4
1.6
1.8
2
Ban
2007
2008
2010
2013
Ultralight
Light
Regular


B. Nicotine & tar levels indicate taste
mean level of endorsement
1
1.2
1.4
1.6
1.8
2
2.2
2.4
Ban
2007
2008
2010
2013
Ultralight
Light
Regular



Supplementary Figure 3 (A, B & C). Trends in perceptions about the utility of pack colour, nicotine and tar levels and the term “smooth” as indicators of cigarette taste. Weighted estimates adjusted for socio-demographic and smoking-related variables along with survey mode and year recruited into the survey.